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# The Use of the Rayleigh Disk in the Determination of Relative Sound Intensities

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# THE USE OF THE RAYLEIGH DISK IN THE DETERMINATION OF RELATIVE SOUND INTENSITIES.

By Harold Stiles.

In the second volume of his Theory of Sound, Lord Rayleigh presents a method for determining mathematically the intensity of sound at very great distances from a rigid sphere, the source of sound being confined to a small area on its surface. Prof. G. W. Stewart* has extended the work of Rayleigh and has calculated the relative sound intensities for sets of points lying on circles concentric with the sphere, the planes of these circles also passing through the source of sound. The points on any one circle were 15 degrees apart and the diameters of the four circles used were respectively 2, 3, 4, and 5 times the diameter of the sphere.

During the summer of 1912 at the State University of Iowa, Prof. Stewart and myself undertook to verify experimentally the theoretical determination and to test the Rayleigh disk as a means for determining relative sound intensities.

Although Rayleigh suggests the possibilities of the disk, we were unable to discover any report of its use in the actual determination of sound intensities in the open. A modification of the Rayleigh disk apparatus which we used consisted of a brass tube 5 cm. in diameter and in length about three-fourths of the wave length of the sound produced.

The tube is drawn to scale in Fig. 2. At the point t is located a thin paper diaphragm one-fourth of a wave length from the open end of the tube. In the constricted portion B a circular mirror 6 mm. in diameter is delicately suspended by a quartz fiber so as to make an angle of 45 degrees with the axis of the tube. Light from an illuminated scale passes through a small window at B and is reflected by the mirror along the axis of the tube through another window at C to the observing telescope. Alternating currents of air in the resonating tube deflect the disk, the deflection being proportional to the energy.

*Phys. Rev. vol. XXXVIII, No. 6, December, 1911.

Fig. 1 shows the sphere and tube mounted near the edge of the roof of the new Physics building about 75 feet above the ground and no other buildings within several hundred feet. The roof in the neighborhood of the apparatus was covered with ¾ inch hair felt. The sphere was constructed of cement, the wall being about 5 cm. thick. The sound was produced by an electromagnetically operated C fork placed in a funnel from which the sound was conducted along the roof through a pipe 25 feet long to the vertical pipe shown in Fig. 1. A watersealed joint at L made it possible to rotate the sphere about a vertical axis. A set of observations was made by placing the sphere so that the opening was turned away from the Rayleigh disk tube and then rotating it through 180 degrees until in the position shown in the figure, readings being taken for each 15 degrees. The results were then plotted as shown in figures 3 and 4, the curves indicating the theoretical values and the small circles the experimental results. These results are from single sets of observations and not the average of several.

The chief sources of error in the experiment were the inconstancy of the tuning fork, the absorption of energy by the resonating tube, and air currents which tended to disturb the disk. It is quite possible that the experiment may be performed under more favorable conditions, giving even closer agreement between the experimental and theoretical values.

The results already obtained seem to indicate that the Rayleigh disk may prove to be very useful apparatus in the determination of relative sound intensities. A more complete account of the experiment may be found in the Physical Review, Vol. 1, No. 4, April, 1913.

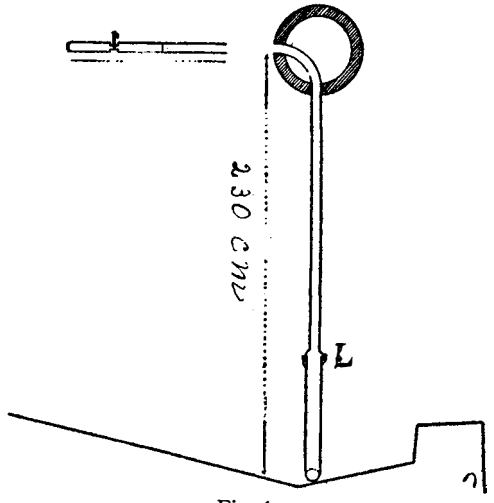


Fig. 1.

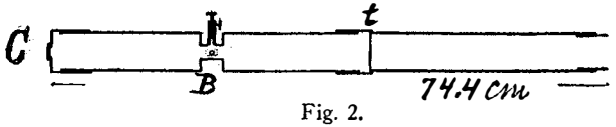


Fig. 2.

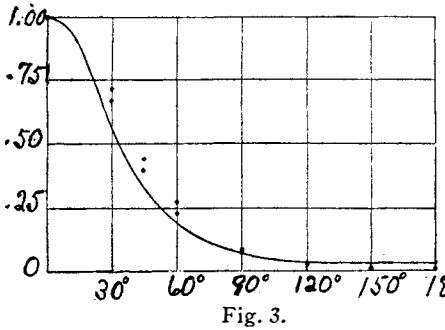


Fig. 3.

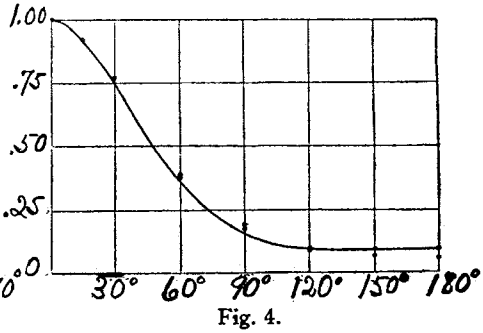


Fig. 4.